A short tutorial on the possibilities and future perspectives of electron microscopy techniques to measure particle number size distributions of nanomaterials.

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Nanotechnology (NT) is the art, science and engineering for manipulating objects at the 1 - 100 nm scale (Nanoparticles (NP)) and opens up a tremendous field of new applications beneficial to mankind and the environment. Amongst others, the food and cosmetics industries have started using NP to increase to quality of their products. However, despite the beneficial use of NP in many products, their interaction with biological systems and ultimately their fate in the environment is still poorly understood. The reason for this lack of knowledge is to a large extent due to our inability to reliably detect any quantify NP, especially in complex matrices. The European Commission's recommendation of the definition of a nanomaterial is based on the particle number size distribution of the respective material and includes "natural, incidental or manufactured material containing particles, in an unbound state or as an aggregate or as an agglomerate and where, for 50 % or more of the particles in the number size distribution, one or more external dimensions is in the size range 1 nm–100 nm" [1]. Thus, the application / development of analytical techniques that allow establishing particle number size distributions will be crucial from a regulatory perspective.

Electron microscopy (EM) in combination with image analysis is promising technique which provides particle number based results. In this tutorial an overview of the possibilities of different electron microscopy techniques, including scanning and transmission electron microscopy, with respect to NP analysis will be given. In addition, a new software tool to automatically extract particle size distributions from recorded EM images, developed within the EU-FP7 project 'NanoDefine', will be presented. However, although EM operations and analysis can largely be automated, the quality of the results will strongly depend on the sample preparation and different approaches to produce an optimal samples will be discussed in the second part of this tutorial.

[1] EC (European Commission), Off. J. Eur. Union 2011, 275, 38–40.